

REMARKS

In the above-identified Office Action, the Examiner has rejected claims 1 - 8 under 35 U.S.C. §102(a) as being anticipated by EP 962,556. Claims 1-5 have been rejected under 35 U.S.C. §102(b) as being anticipated by the patent to Graef et al. (5,935,320). Further, claims 6-8 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Graef et al. in view of EP 915,502.

The above-described rejections are addressed as follows:

A) Discussion of the Invention

Before specifically addressing the above rejections, we first briefly summarize Applicant's invention. The invention resides in a heat-treated silicon wafer, a silicon wafer for semiconductor device manufacture, a method of manufacturing a silicon ingot, and a method of determination of the doped nitrogen concentration of a silicon wafer. The silicon wafers recited in the claims have a nitrogen concentration, which are effective to reduce crystal defects in the silicon wafers through heat treatment.

B) Rejection Under 102(a) and 102(b)

i) The Cited Art Must Set Forth Every Element to Establish a *Prima Facie* Case of Anticipation

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." See, M.P.E.P. §2131m citing *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

ii) The Cited Art Fails to Set Forth All the Claim Limitations

EP 962,556 was published December 8, 1999. The PCT application as the origin of the present US patent application was filed on August 25, 2000 with the priority of the Japanese patent application filed on August 27, 1999. Therefore, the present US patent

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application claims a priority date of August 27, 1999 such that EP 962,556 cannot be prior art under §102(a).

However, US Patent No. 6,077,343 is equivalent to EP 962,556 and US Patent No. 6,261,361 as a divisional patent thereof were issued on June 20, 2000 and July 17, 2001, respectively, and were filed on May 25, 1999 (Parent). The US Patents will be denominated herein (and argued) as EP 962,556.

Claim 1 is amended to add a limitation that the sliced silicon wafer from a silicon ingot which is prepared by the Czochralski or the MCZ method includes the void defects of a wafer surface layer thereof, wherein the void defects may be reduced in the subsequent heat treatment. The limitation that a silicon wafer from a silicon ingot prepared by Czochralski or the MCZ method includes a nitrogen concentration and void defects to be reduced during the heat treatment is not disclosed in EP 962,556 or Graef et al.

EP 962,556 discloses a silicon single crystal wafer having neither a V-rich region nor an I-rich region, but having a N-region with an extremely low defect density on the entire surface of the crystal ([0016] in col. 3). Since the silicon wafer according to claim 1 has a V-rich region and an I-rich region, EP 962,556 does not teach or suggest the claimed invention.

Graef et al. discloses nitrogen non-doped silicon wafers (CZ1-CZ3) prepared by the CZ method, which were annealed (Example 1); a nitrogen doped silicon wafer prepared by the Czochralski method, which was not heat treated (Example 2); and a nitrogen doped silicon wafer (FZ1) prepared by the FZ method, which was annealed in an oxygen/nitrogen atmosphere (Example 3). Since the silicon wafer recited in claim 1 is prepared by the Czochralski method or the MCZ method with nitrogen doping and heat treated under non-oxidative atmosphere, Graef fails to teach claim 1.

Claim 2 is amended to add a limitation that the silicon wafer from the single crystal is prepared by the Czochralski method or the MCZ method with V/G1 higher than $0/18 \text{ mm}^2 / ^\circ\text{C min}$ and not exceeding $0.4 \text{ mm}^2 / ^\circ\text{C min}$. EP 962,556 discloses the silicon single crystal wafer being prepared by the Czochralski method with a pulling rate of 0.141 to $0.180 \text{ mm}^2 / ^\circ\text{C min}$

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([0050] in col. 9). Therefore, the instant invention is not anticipated by EP 962,556. Since Graef does not teach the pulling rate in the Czochralski method, claim 2 is not anticipated by Graef, either.

Claim 3 is amended to recite the atmosphere for the heat treatment. Since claim 3 is dependent from claim 1 and claim 1 is novel as described above, claim 3 is novel.

Claim 4 is amended to add a limitation that $V/G1$ is higher than $0.18 \text{ mm}^2 / ^\circ\text{C min}$ and not exceeding $0.4 \text{ mm}^2 / ^\circ\text{C min}$. EP 962,556 discloses a method of making a silicon single crystal by the Czochralski method with a pulling rate of 0.141 to $0.180 \text{ mm}^2 / ^\circ\text{C min}$ ([0050] in col. 9). Therefore, EP 962,556 fails to disclose the instant invention. Since Graef does not teach the pulling rate in the Czochralski method, Graef fails to teach claim 4.

Since the amended claim 5 is dependent from claim 2 and claim 2 is novel as described above, claim 5 is novel.

Claim 6 is amended to add a limitation that the annealed silicon wafer achieves a predetermined oxide film withstand-voltage non-defective ratio with TZDB test after removal of a surface layer of $3 \text{ }\mu\text{m}$. Since EP 962,556 and/or Graef does not disclose the $3 \text{ }\mu\text{m}$ surface layer removal, claim 6 is novel over the references.

Claim 7 is amended to add steps of heat-treating a silicon wafer under a non-oxidative condition such that the void defects of a surface layer are reduced; removing the surface layer, and conducting TDDB and/or TZDB tests. Since EP 962,556 and/or Graef does not disclose the surface layer removal step, claim 7 is novel over EP 962,556 and Graef.

Since claim 8 is dependent from claim 7 and claim 7 is novel as described above, the invention according to claim 8 is novel.

Claims 9-14 are newly added such that claims 9-11 are dependent from claim 1, claims 12 and 13 are dependent from claim 1 via claims 9 and 10, and claim 14 is dependent from claim 2. Since claims 1 and 2 are novel as described above, claims 9-14 are novel.

C) Rejection Under 103(a)

i) Basic Criteria to Establish a *Prima Facie* Case of Obviousness

To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on Applicant's disclosure. *In re Vaeck*.

ii) The Cited Art Fails to Disclose the Claim Limitations.

Claims 1-5 are not obvious under 35 U.S.C. 103(a) over Graef in view of EP 962,556, since EP 962,556 and/or Graef fails to teach all the limitations recited in each claim as set forth above. More particularly, neither Graef or EP 962,556 does not teach or suggest a V-rich region or an I-rich region.

Claims 6-8 are amended as described above and all limitations recited in each claim are not disclosed in Graef and/or EP 962,556. EP 915,502 teaches a method for heat treatment of a silicon wafer such that the silicon wafer is heat treated at a temperature of 1150 °C to 1300 °C for 1 sec to 60 sec in a mixture gas atmosphere of hydrogen and argon, but does not disclose or suggest the doping with nitrogen. Further, neither Graef et al. nor EP 915,502 fails to teach the removal of the surface layer from the silicon wafer. So, claims 6-8 are not obviousness over Graef in view of EP 915,501.

Claims 9-14 are newly added and are dependent from claim 1 or 2 as described above. Since claims 1 and 2 are not obvious over Graef, EP 915,502 and EP 962,556, claims 9-14 are not obvious over the cited references.

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D) Conditional Request for Interview

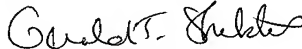
In light of Applicant's amendments and argument, Applicant believes that the claims are in condition for allowance. Nevertheless, if the Examiner believes that claims of the application should be finally rejected, or if the Examiner has issues that merit discussion, then Applicant requests a telephone interview to try and efficiently resolve all open issues.

In view of the foregoing, Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Applicant hereby requests reconsideration and reexamination thereof.

With the above amendments and remarks, this application is considered ready for allowance, and Applicants earnestly solicit an early notice of same. If the Examiner believes that a telephone conference would expedite prosecution of the subject application, he is respectfully requested to call the undersigned attorney at the telephone number listed below.

Respectfully submitted,



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